

with Dr Jackson's reply

AN
INTRODUCTORY LECTURE,

ADDRESSED TO THE

Students of the Westminster Hospital,

AT THE

COMMENCEMENT OF THE SESSION

1871-72.

THE RELATION SUBSISTING BETWEEN MEDICINE AND THE
OTHER ARTS AND SCIENCES.

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INTRODUCTORY LECTURE,

ADDRESSED

TO THE STUDENTS OF THE WESTMINSTER HOSPITAL, AT THE
COMMENCEMENT OF THE SESSION 1871-72.

MR. HOLT AND GENTLEMEN,—It has appeared to me that it may be to the advantage of those now commencing their studies, and perhaps not uninteresting to those who have passed through the probationary period of studentship, to have placed before them the relation which exists between the Science of Medicine and those other branches of human inquiry which are commonly included under the general term the Arts and Sciences.

I propose therefore to bring, as it were into a mental focus, the scope and object of those sciences and arts which exercise any influence over, or are, however remotely, connected with, the practice of medicine and surgery.

I thus hope to offer to the intelligent and enterprising student a glimpse of the links which bind together the various branches of human knowledge, and the general bearing they have on the science and practice of medicine.

The following observations, then, are addressed especially to those who are now commencing, or are still pursuing,

their studies, and preparing themselves for the medical profession. I propose to point out the relation which subsists between medicine and other branches of science and art, its intimate connection with them, and thus determine in what respects it is to be considered as a science, and how far it may be regarded as an art. It is hoped that the magnitude of the subject brought before them will not embarrass or dishearten them, but rather encourage them to master all that is needful to admit them into a profession so honorable and useful.

A definition of the sense in which the terms Medicine, Science, and Art are used, may at the outset be desirable.

The term Medicine includes the Principles and Practice of Medicine and Surgery, Obstetrics, and Therapeutics.

The words Science and Art are so often used as convertible terms, that it is also very necessary to define the distinction between them.

The word Science comprehends all investigations into the powers and properties of matter, inorganic as well as organic, and consequently embraces all the natural sciences, as well as the abstract or exact.

The word Art is applied to whatever is produced by the mental or manual skill of the individual, or by a combination of both.

MATTER AND FORCE.

The observation of natural phenomena, and the endeavour to account for the forces daily operating around us, is a faculty peculiar to man. The earliest history of our race brings before us attempts to describe the origin and formation of the world, and the several results of creative force.

In the early history of most nations there have not been wanting men who, by the pretension of preternatural gifts, or by their devotion to the service of their deity, have acquired the reputation of fathoming the secrets of nature and of accounting for the cause of many natural phenomena. As the mind of man, however, in succeeding generations, increased in force and grasp, and as observation became more extended and accurate, the mind became sceptical, and doubted the correct interpretation of many natural phenomena.

To doubt is to inquire. To inquire is to observe, and patiently collect material for comparison, and thus the foundation is laid for a sound knowledge of the laws of the physical world.

To observe that a stone falls to the ground when let drop, that it will with the same certainty fall to the ground however high the arm may throw it—that in its ascent it rises with a gradual decreasing force, while in its descent it falls with an ever increasing velocity—are facts which must have been observed as long as man has possessed the faculty of observation ; but it was not till Newton applied himself to the investigation of such natural phenomena that the laws of these movements became determined, and thus the force of gravitation became reduced to a law, capable of interpreting, not only the movements of the simpler forms of matter around us, but of determining the laws which regulate the motions of the planetary bodies in space.

Let it be remembered that all our knowledge of the laws of the material world (physics) is based on correct observation.

Science proper comprises two great divisions :

1. Abstract or exact, or deductive science.

2. Natural science or physics. or inductive science.

The sciences of quantity and number—geometry and arithmetic—constitute what are called mathematics, and represent abstract, exact, or deductive science.

It has been truly said that the truths which mathematics teach are necessary truths. They are truths of themselves, and wholly independent of experiment. They are established entirely on reasoning, and every stage of proof of the proposition offered is a truth the opposite of which involves a contradiction.

Deductive science proceeds from general propositions to particulars; inductive science, from particular facts to some general expression which represents the law on which the particular facts depend.

Natural or inductive science by observation collects and examines the properties and forces of the material world.

If a series of facts are observed to recur with some constant property or result, observation presumes that this property or result is essential to the manifestation of the facts. Inductive science collects, therefore, by observation, facts, classifies them and generalises till it finds one general expression which represents the law on which they depend.

The domain of geometry is the universe. The ordinary land surveyor who measures a field, equally with the astronomer who calculates the distances of the heavenly bodies, derive their fundamental principles from this branch of mathematical science. Inaccessible distances and heights are measured, figure and bulk are calculated, by it; the sun's distance, the earth's orbit, and the most useful and most exact astronomical facts, are found by it. The ship's course at sea is traced by it; her exact spot on the chart is laid down by it; the distance she has sailed, and the direction of her port of departure and

that to which she is bound, are accurately known and traced by it.

In the observation and classification of natural phenomena, and in the fixing of some grand expression governing them, it has been found possible to apply the test of exact science to their elucidation; so that the applications of arithmetic and geometry to the interpretation of natural phenomena are sure tests for the correctness of the law at which generalisation has arrived. In whatever natural science they can be applied the properties of an exact science have been reached.

In astronomy and dynamics this has been attained; and they therefore may be removed from the class of inductive and placed among the exact or deductive sciences. So, also, may chemistry claim to be admitted into this section of science, by the adaptation of numerical formulæ to represent the composition of matter.

The application of the science of numbers and proportion to express the power or energy of any special force has extended to branches of natural science which some years since would have seemed utterly incapable of being numerically valued. In this attempt to place a numerical equivalent on any given force, it must be very evident that a unit of measure for every form of force must be found before any calculation can be attempted or any value placed on the energy to be measured.

It is far beyond the scope of this Lecture to do more than hint at the application of the science of numbers to the estimation of the powers and energy of matter under different circumstances; I may, however, observe that—The numerical value of any given force calculated from its unit permits the expression by algebraical formulæ of the energy of the various powers of matter, and consequently the laws of

motion, and of the moving powers of the different forms of matter, solid, fluid, or æriform, are now defined with accuracy and distinctness.

The position of those branches of natural science which are brought into relation with exact science by the application of geometry and arithmetic is pre-eminent. They are characterised by exactitude and certainty, and the laws governing them are demonstrable, conclusive, and definite.

It may appear to many that the application of geometry to any branch of medical study savours of pedantry, or as a mere scientific conceit. But Professor Haughton, of Dublin, in his 'Lectures on Animal Mechanics,' has clearly demonstrated the economy of vital force as shown by the application of geometrical laws to the phenomena of muscular energy, and the researches and observations of Dr. Radcliffe into the dynamics of nerve and muscle are calculated still further to establish the connection between the animal or vital forces and those pertaining to unorganized matter.

In no branch of physics has the application of the science of numbers and proportion been more successfully employed than in chemical action.

Whenever any change in the composition of a natural substance occurs, that change is referred to chemical action. Chemistry, therefore, has regard to the intimate composition and structure of matter. The changes which matter undergoes, whether by the influence or agency of heat, whether by contact or mixture, by the agency of electricity, or even by motion alone under special conditions, are almost infinite.

The conditions under which, and the causes which bring about, these infinite variations in the composition of bodies, have only been systematically investigated and certain laws discovered within the last 150 years; it may, perhaps, be

more correct to say within the last 100 years. Before that, chemistry was but an empirical art. The alchemists, with their fanciful theories, were its representatives.

It is here desirable to mark the results which have followed the application of the science of numbers to the operations of chemical action, and the consequent development of the theory of definite proportion in the composition of all material things. It may be confidently stated that the adaptation of the theory of definite proportion to the composition of matter and the establishment of the atomic doctrine numerically stated—that is, that the elementary constituents of bodies combine only in certain definite proportions numerically valued—has brought chemistry to the very verge of an exact science.

It is almost impossible, so many are the distinguished chemists who have contributed to this result, to assign to any one the origin of its discovery.

According to Brande ('History of Chemistry,' p. 60), between the years 1792 and 1802 Dr. Richter, of Berlin, published his 'Geometry of Chemical Elements,' containing tables showing the weight of each base capable of saturating 100 parts of each acid, and the weight of each acid capable of saturating 100 parts of each base.

He observed that in all these tables the bases and the acids followed the same order; and further, that the numbers in each table constituted a series having the same ratio to each other in all the tables. Thus, if 100 parts of sulphuric acid were saturated by 100 of soda, 200 of potash, 300 of barytic oxide, then the table of nitrates exhibited a similar law of definite proportion, and soda, potash, and barium oxide stood in the relation to each other of 1, 2, 3.

Dalton, Wollaston, and Gay Lussac, may be said to have

completed these investigations, and finally established the atomic theory, or the doctrine of definite proportions, embracing every substance in nature, whether solid fluid, or gaseous. Chemistry, therefore, as a science, has by the application of the modern system of notation, and the adaptation of the properties of proportion and number to the composition of matter, been brought within the limits of a mathematical science.

The part which heat, light, electricity, magnetism, and motion, take in the development of chemical action has been demonstrated and illustrated by the researches of more modern times.

These forces, or imponderable agencies, or affections of matter, as they have been termed, are now acknowledged to be reciprocal or correlative. Neither of them, taken individually or abstractedly, can be said to be the essential or proximate cause of the rest, but that each may as a force be converted into, or may evolve, the other. Thus, heat may develop electricity, electricity produce heat, magnetism motion, motion heat, and so of the rest, and none can act independent of the other.

This lofty and interesting, and, moreover, philosophic view of the correlation of the several forces disturbing the equilibrium or static condition of matter, has been worked out and made intelligible by a distinguished member of the bar, Mr. Grove, whose contributions to that branch of physics known as electro-galvanism place him among the most eminent of the scientific labourers of the nineteenth century. His nitric acid battery has long been regarded as the most powerful combination for the development of electro-galvanic force.

Geometry and arithmetic are the handmaids, then, of in-

ductive science. By the application of the fixed, abstract, and exact truths of these sciences to the phenomena of the natural world, the latter have been grouped together, and final determinate laws in respect to the operation of force on matter have been calculated and settled.

The application of geometry and mechanics to the study of physiology has already developed a branch of most useful investigation under the title of animal mechanics, which, originating with the Professors Weber, of Basle, has lately been the subject of most instructive lectures by the Rev. Dr. Haughton, of Dublin, who has submitted a geometrical classification of the muscles of animals, with the object of showing the economy of vital force in the operation of muscular energy.

The branches of inductive or natural science (physics) which have special reference to medicine as a science are—

1. *Chemistry*, which teaches the powers and properties and composition of matter. It demonstrates those agencies by which change of composition is brought about. It brings within its teaching every branch of natural or physical science.

The physical sciences most essential to the student of chemistry are some acquaintance with mechanics, that is, that branch of physical science which investigates the effect of motion and the moving powers; of hydrostatics, which treats of the pressure of water or other liquids; hydraulics, which treats of the laws of motion of fluids; pneumatics, which treats of the pressure and the motion of air or other gaseous or elastic fluids.

Some knowledge must be acquired of the laws of heat; its generation by friction, compression, and percussion, and by the mutual action of substances one with another.

Also, of the laws concerning the development and generation of electric, galvanic, and magnetic force, and the correlation of these with each other.

Optics, as a science, must receive some attention, for this treats of vision as well as the nature and properties of light, the change it undergoes in its qualities or direction in passing through bodies of different shapes and densities.

The chemical agency and the heating force of different portions of a ray of light (actino-chemistry) must also receive a share of attention.

The subject of spectrum analysis has become so important a part of chemical science that it is now an essential element of teaching.

These several sciences teach a knowledge of the laws of the material world. They examine and analyse the fundamental powers and properties of matter, investigate the forces disturbing the inertia of matter, equally with those which maintain it in equilibrium. They deal with matter as a ponderable agent, as solid, fluid, or aeriform—or imponderable, as in the phenomena of heat, electricity, light, or sound.

2. *The science or knowledge of organized structures.*—This includes human and comparative Anatomy and Physiology and Botany, or vegetable anatomy and physiology, including a knowledge of the structure, functions, uses, and geographical distribution of plants and animals.

A knowledge of the structure of organized beings, animal and vegetable, thus forms a distinct branch of natural science.

It is an extensive field of study; it comprehends a minute and accurate knowledge of the structural elements of living beings, and the object of this accurate knowledge of struc-

ture is to open the road to a knowledge of the functions of the several organs of which the body is composed. And this branch of natural science (physiology) can only be successfully followed when guided by some knowledge of the physical laws.

The basis of medicine, as an art, rests on a minute and accurate knowledge of the structure of man and of organized structures generally, with an equally accurate knowledge of the uses of the several organs and tissues of which the body is composed.

The province of the anatomist would be comparatively unproductive if it accomplished no more than the marking out of the textures, bones, muscles, nerves, blood-vessels, of which the body is built up.

Anatomy and Physiology are inseparably linked ; with the study of the structure is immediately associated the teaching of the uses and functions of the parts which dissection reveals.

The connection between Anatomy and Physiology and the other natural sciences will now be apparent.

The vital forces—that is, the functions and operations of living organisms—are but exemplifications of the economy of the natural laws of the material world.

These vital forces not only always operate in accordance with the physical laws, but they are formed, created, or evolved, in strict obedience to or dependence on those laws. The functions of the heart act strictly in accordance with the laws of fluid motion, those of the lungs equally with those of elastic fluids ; the powers and action of muscles are striking examples of mechanical energy—every muscle in its action illustrates one or other of the lever powers.

The structure of the eye is formed in strict accord-

ance with the laws of light, that of the ear with those of sound.

It is in the investigations of physiological and pathological processes that the science of chemistry has in recent times acquired such importance in relation to Medicine. Without the aid of this science interpretation of many vital phenomena would be impossible. The physiology of respiration and its products, the composition of the secretions and excretions, the constituents of the blood, of the bile, of the urine, would be unknown, and the value of a comparison of the composition of these in health and the alterations effected by disease or disordered function would be impossible. Without aid from the science of chemistry medicine would have little claim to be ranked as a science. Doubtless there are many functions and processes which cannot yet be explained by reference to any definite chemical law. The process of digestion is partly chemical, that is, substances undergo in the stomach change of composition and rearrangement of their molecules; but how this conversion of vegetable farina, albumen, and sugar, or of animal flesh, albumen, and fibrin, by the digestive process, into a fluid chyle capable of sustaining the wear and repairing the waste of the organism is accomplished is not yet known. So of the manner in which the chief secretions of the body are formed, although a kind of vital chemical process is apparent in them, we are yet feeling our way towards a correct interpretation of them.

The singular excitement of muscular action and of nerve force by the electric, galvanic, and galvano-magnetic currents, brings the phenomena of the cerebro-spinal function in close apposition with the electro-galvanic forces of the material world.

Nerve action, that subtle force, so like in some of its manifestations the action of an electric agent, exhibiting so many phenomena similar yet not identical, is receiving its proper share of attention, and in the hands of my colleague, Dr. Radcliffe, our knowledge is advancing in a direction calculated to place the treatment of nerve disease on a more scientific basis than heretofore.

These, then, are the more prominent characteristics of those branches of human knowledge which are based on observation, and to which the term natural or inductive science appropriately belongs—examining, explaining, and estimating the powers and properties of matter, and which are more or less directly required as the basis of investigation into the laws of health and disease.

But in all these inquiries observation, to be effective, must be trained, and there is no training so effective in preparing the mind for correct observation as that derived from mathematical science. It is the foundation on which natural science or the science of physics rests.

ART.

I will now ask your attention to those other branches of intellectual knowledge comprised under the general term Art.

The arts include whatsoever is effected or produced by the mental conception, aided by the manual skill, of the individual mind. Operating on, or assisted or directed by, some one or more of the physical laws which science interprets, art produces combinations, or effects, or results, which would not or could not occur except through the contrivance or conception of human ingenuity.

The arts severally appeal to the perceptions of sense or to the mental emotions, and thus enhance the corporeal as well as the intellectual pleasure of mankind. They are prompted by the imaginative faculty, which they severally gratify and excite.

These arts, in their fullest development and in their loftiest conceptions, are indices of the highest degrees of civilisation, which it is their mission to elevate and refine.

The arts, the characteristics of which I would more particularly signalise, are—

Language, out of which springs Poetry, Oratory, Rhetoric, and the various forms of expressing thought in words, as the historical, the didactic, the dramatic, the dialectic—

Painting, Sculpture, Music, Architecture.

Poetry, through the harmony of words metrically arranged, excites by the description of heroic acts, soothes and pleases by the ideal of sylvan scenes and rustic forms, or portrays the gentler emotions of love and friendship. It exhilarates by the play of wit and humour, and often denounces or satirises the follies, the weakness, and wickedness of mankind.

Poetry and music may be regarded almost as twin sisters.

Music is the art or science, as it is sometimes termed, of harmony.

It may be safely asserted that the emotions and passions of the mass of mankind are more easily excited and pleased by the harmonies of sound, by the melody of vocal or instrumental music, than through the influence of painting or sculpture.

The influence of music over savage and untutored minds is proverbial.

As an art, it deals in the combination of sound producing concord. Noise is sound; music is sound; but noise is sound without concord, that is, without proportionate or orderly vibrations; music is sound with regular vibrations or proportioned intervals.

Music becomes a science when the laws of acoustics are applied to the analysis of harmonics. But music may be composed, and the most exquisite examples of musical harmony produced, without the composer having a scientific knowledge of the laws of acoustics, or the application of the science of numbers and proportions to the elucidation of the theory of the molecular undulations of the air.

Painting expresses and fixes, by form and colour, all that may delight the eye, and revive in the mind, through the art of drawing, the ideal of things not present. It may convey the mind, through the imagination and skill of the artist, to periods of the remotest history, and delineate acts which the historian may only have imperfectly described in words; or it may, through the harmonies of light and colour only, produce a sense of pleasing satisfaction scarcely definable; or, by the representation of scenes of humour or of the various phases of social life, amuse, instruct, and admonish, by its truthful delineation of character, custom, and incident.

Sculpture.—Sculpture, like painting, has its origin in the ideal; it is the representation of objects in stone, wood, or metal. As an art, it probably arose before painting. Rude images of deities, men, or things, were roughly modelled in wood, clay, or stone, long before the hand of man was skilful enough to represent by line and colour on a flat surface the ideas the mind conceived.

Painting and sculpture, in one sense, have an immediate

relation to the study of medicine. It is through the science of anatomy that this relationship exists. No one acquainted, however superficially, with the works of the great masters of Italian art, but must recognise and admire their intimate and correct knowledge of the anatomy of the human frame. Their pictures and their statues are convincing evidence of their thorough knowledge of the morphology of both human and animal structure ; and when we turn to the products of still earlier periods of art, we no less admire the exquisite grace than we admit the profound knowledge of anatomy which every specimen of Greek art displays. Nor is anatomy the only tie which binds these arts to science ; the rules of perspective are essentially developed on geometrical principles, and these the painter and sculptor must thoroughly understand and work by.

Architecture.—The art of building rests, perhaps, on a wider sphere of scientific knowledge than either painting or sculpture. Untaught genius has, by the simple force of devotion to his art, acquired the technical power requisite for perfection in both sculpture and painting, although the examples are rare.

Not so, however, in the art of building. In this art imagination may suggest and genius may create the beautiful in form or in elevation, the graceful and appropriate in detail ; but these results must be based on the most thorough and ample knowledge of the laws of mechanics. Calculations the most refined are needed for the materials employed ; their strength and power of resisting strain must be known to the fraction of a unit. Not only this, but a knowledge of the simpler mechanical arts of construction, the art of carpentry in its widest sense, even the ruder working of the bricklayer, the mason, and the joiner, must be well known to

him ; and when to all this is added the requisite knowledge of the decorative arts, the effect of colour, the effect of stone carving to aid the completeness of his design, we bring together in one mind such a variety of scientific knowledge, not as accomplishments only, but as essentials to the exercise of his art, that the architect may fairly claim the highest position among the arts in his relation to pure and applied science.

With the civil engineer art is subordinate to science, and his profession is that of a science rather than an art. Taste in construction is subservient to utility.

The education of the engineer, whether civil or military, is of the highest mathematical and scientific character. He must be thoroughly acquainted with every branch of natural science, for he is ever contending with the powers and forces of matter—overcoming, directing, or using them. The works of modern engineers, both English and foreign, testify to the gigantic power which science gives to human energy when thus directed.

Everything produced by art is subject to the dogma of opinion. The influence of art is always proportioned to civilisation, education, and refinement. Taste, which is but the appreciation of whatever is excellent in art, is, nevertheless, an arbitrary quality ; and though it will be often found most perfect and correct in those whose powers of observation and judgment have been disciplined or trained by special education, yet it is occasionally found quite independent of special training, and existing even as a *national* as well as an individual quality. The French, the Italian, the Spanish, the German, the Chinese, Japanese, the Indian, have each their national style or taste, both in form, colour, and object.

It may be, moreover, said of art, that its influence over human emotion or human action is indefinite rather than definite; that it can never be reduced to any fixed or determinate law, being largely subject to the capricious influence of the individual, as much as it is to the not less unstable opinion of the many.

An art which shall have exercised a marked beneficial and widespread influence over mankind in one generation of men shall lose that influence amongst a subsequent race.

It may be doubted if poetry, oratory, elocution, if architecture or sculpture, exercise in modern times any influence at all proportioned to what they excited among the Greeks or even the Romans.

What connection, then, have these arts with the science or profession of medicine?

They represent accomplishments rather than requisites, it is true; but the medical mind which justly estimates the kind of mental training peculiar to each art, and the points of character most strongly developed by such training, as well as the connecting links which bind the arts to physical science, will be in a position to obtain a more intelligent view of the relation of medicine to art, and become a better judge of the effect of the mental strain which art at times demands of her followers, and the influence of that strain on the health of the artist, than one not so accomplished.

MORAL SCIENCE.

To complete this hurried and necessarily imperfect sketch of the several branches of human intelligence, with the purport of placing the science of medicine in its proper and appropriate position, mention must be made of those subjects

of mental action which embrace an inquiry into the operation of the human mind, and which are designated the moral sciences, or moral philosophy.

Medicine, as a practical science, has to deal largely with the mental operations of man. The laws, so far as they have been determined, which govern the acts of the individual, whether in relation to himself alone or in his aggregate or social position, should be an object of inquiry to every practitioner.

Moral philosophy, comprehending in its largest sense a knowledge of the duties of life, is an inductive science, deriving its rules and laws from experience. The duties of life must be regulated or estimated by some standard acknowledged by the majority of mankind.

Observation and experience prove that men's acts, whether of the individual or the mass, produce one of two results—beneficial to the individual or to the mass, or detrimental and injurious. The estimate of the quality of these acts belongs to ethics, which, as a science, determines the standard of right and wrong, by which eventually law and order become established and fixed rules are formed for the government of mankind in the social state.

Moral philosophy investigates, determines, and defines the duties of life. It includes the duties of man to himself as well as those which belong to the complex social state in which he lives. It defines the difference between right and wrong, and it fixes the limit to the action of the will of the individual and regulates and governs his conduct for the benefit and welfare of the many.

A large and comprehensive branch of moral philosophy confines itself to the study of the human understanding, investigates the conditions favorable to its development,

inquires into the origin and source of all the mental processes, separates the purely somatic or corporeal from the psychic or spiritual phenomena of the intellect, and endeavours to analyse every emotion and sensation, and place them in their true relation to the intellect of the individual.

This subject, which was formerly designated as a branch of metaphysics, is now more appropriately termed psychology. It is a branch of philosophy worthy the devotion of great minds, for those of lower calibre are sorely given to vain and inconclusive speculation in their attempts to interpret the laws of the human understanding.

The two most essential branches of moral science, and which are practically in daily operation, are—1. The science of law and political economy; 2. The science of religion.

I take the last first. Theology, the knowledge of God and of divine things, is at once the profoundest and the most important, and to most minds the most needful subject, to which the powers of the human mind can be directed.

It nevertheless involves the largest amount of controversy, and divides mankind into greater subdivisions of cognate and hostile sects than even language or race.

Its foundations rest in the depths of the human mind craving for something above and beyond our finite worldly existence. It is developed neither by purely inductive nor deductive or abstract reasoning.

The greater part, and that which takes most tenacious hold of the convictions of men, is simply dogmatic, and its strength, therefore, is proportioned to the reliance or faith of the individual on the utterances of authority, or those recognised as having authority to declare such and such to be articles of faith and truth.

In some form or other it brings comfort and consolation

alike to the ignorant as to the learned, to the ill educated as to the worldly accomplished, to the poor as well as to the rich, to the lowly humble as well as to the wealthy proud, to the vicious as well as to the virtuous. It offers hope to some, and teaches gratitude to all. In the highest, purest, and most philosophic form it endeavours to rise to the conception of an all-wise beneficent Being, the adoration of whom is best expressed by a life devoted to the exposition of those laws to the unveiling of which man's intelligence is specially adapted. To the human understanding has been given the power to comprehend the nature of the forces acting on matter, and it seems almost as if there were in the range of his intellect but two things his intelligence cannot grasp—the infinity of space (the universe), and the infinity of minuteness: our senses seem incapable of conceiving either form of infinity.

The most powerful microscopes applied to the investigation of organic material tell us plainly that there is much beyond the limits of a thousand diameters of magnifying power which the observer craves to know; and the mind becomes bewildered in the contemplation of that infinity of space and distance which astronomical observation proves, that from either end of a base line of 182,000,000 of miles, (the diameter of the earth's orbit,) the nearest star does not subtend an angle of one second of arc.

The science of law and political economy, which comprises jurisprudence or a knowledge of the civil law, and all its ramifications in relation to property, real and personal, the political rights of individuals, their personal relations to each other, their duties to the state and to the bodies corporate into which the interests of society may have caused individuals to enrol themselves, is one of the most comprehensive and

certainly the most practical of any of the moral sciences. Its objects and principles are of importance to every individual of the body corporate, for it has regard to his welfare and security in the social state; and while preserving and respecting the limits of personal right, it maintains and regulates those rights for the welfare of the community at large.

I have thus hastily glanced at the several branches of natural science, and still more cursorily have mentioned the objects and characteristics of what are usually regarded as the arts, and certain branches of moral philosophy.

I desire now to place before my young hearers somewhat more distinctly the claim which medicine possesses to be considered a science, and to show how far it is an art dependent on the personal skill, judgment, or tact, of the individual; how far it is capable of being subject to fixed and determinate laws, and the extent to which these laws bind and regulate the judgment and opinion of the practitioner.

The learned professions, law, physic, and divinity, have severally for their object the security of the person and property, the maintenance of the health, and the welfare of the soul of the individual.

The practice of the law and the duties of ecclesiastics may be efficiently and successfully conducted without any knowledge of, or assistance from, those sciences which teach the powers and properties of matter. The education of the lawyer and the clergyman will be the more complete, and the discipline of their intellects the more perfect, the greater their acquaintance with science in general; but a knowledge thereof is not an absolute essential to the successful practice of these professions.

But how different is it with the practitioner of medicine.

There is not one of the natural sciences heretofore named of which he should be ignorant. Many of them are imperatively required, and all are essential to those who would seek distinction or would carry their art to the highest point of usefulness.

To illustrate this necessity, let me especially ask your attention to the scope and object of medical science. An old writer has very pointedly written—“*Medicina divinitus data est, non ut homines a morte, et constituto vitæ termino omninò liberet, sed ut corpus a corruptione et festina dissolutione præservet.*”

The aim and scope of medicine is most rational, most useful, and universally beneficial. It does not pretend to rescue life from its natural termination; but it studies to preserve the body in health, and to free it from those evils or disorders which neglect of the laws which govern and minister to life most certainly entails.

How can so noble a purpose be accomplished? How can such results be worked out? Clearly by a thorough and familiar knowledge of the nature and force of those laws by which life is maintained.

The first essential in the investigation of what concerns either the health of the individual or of that of the community of which he forms an integral part must be based, as already stated, on a perfect and minute knowledge of the structure of man, on his organization, as well as on the proper functions and uses of the several organs of which this structure is made up, and their relation to the external world. On the thoroughness and completeness of this knowledge depends the position which medicine holds as a branch of science.

When anatomy was but little or imperfectly known, the

functions of the organs were but little understood, and, consequently, the true nature of the disorders which mankind suffered were concealed under a mystical jargon which veiled ignorance and obstructed inquiry.

Our knowledge of the structure of organized beings, whether animal or vegetable, both as regards human and comparative forms, has within the last century made such progress that the physiology of life, or a knowledge of the uses and functions of the several tissues and organs, has shed its influence over the investigations of diseased action, and a more rational pathology, to the advantage of medicine as an art, has displaced the fanciful theories of the humourists and solidists; and though, perhaps, no generation will ever be without its empirics or fanciful theorists as to the nature of disease, yet a medical training based on a high scientific education will render it as impossible for one so educated to become a follower of homœopathy, as it is impossible for one trained in the laws of dynamics should be a theoriser or speculator in perpetual motion or spiritualism, or a chemist believe in the transmutation of metals.

To prove the position to which medical science may justly claim among the inductive sciences I would briefly refer to the wider field of observation entered in later years. It is little beyond the present century in point of date that physiology received that impulse as an inductive science which has placed it in the eminent position it now occupies in the sciences collateral and co-relative with medicine.

The genius of Bichat led the way in this instructive progress; and in more recent times, with the aid of the microscope, his followers have taught that what the older anatomists considered as simple tissues or anatomical

elements are in reality of most complex structure, and made of various tissues or elementary structures universally distributed through the organism.

This important branch of anatomical science, essential to the elucidation of the physiology of life, is now recognised as a distinct branch of inquiry and teaching under the name of Histology, or the anatomy of the elemental structures and tissues.

Histology is to anatomy what analysis is to chemistry.

Anatomy roughly teaches the form and position and connection of the bones, the origin and insertion of muscles, their relative position and mechanical power; the courses and direction and relative position of the arteries, veins, and lymphatics; the place and course of nerves and ganglia.

But histology splits up into elemental tissues these several anatomical combinations.

Take, for example, the osseous tissues.

The bones were formerly considered and included among the simple tissues. They were classed as one of the anatomical elements, as was also the muscular tissue, nerve tissue, cartilage, &c. &c. But histology teaches that bone is one of the most complex, as it is one of the highest, order in rank among the tissues. That it is made up of bone-cells, canals, vessels, nerves, and cartilage; that its mineral constituents exist in certain definite proportions, often, however, modified by constitution and disease.

Histology proceeds in this kind of analysis through every texture of the body, investigating and describing the minute microscopical character of the elemental parts of teeth, of cartilage, of connective tissue, of elastic tissue, of hair, horny tissue, hoofs, nails, smooth and striped muscular fibre, of brain substance and nerve, of nerve fibre and nerve-cells

The histological character of these latter anatomical elements have received much attention of late years, and the microscopic researches of Mr. Lockhart Clarke are amongst the most distinguished and valuable of the present time, and certainly no living observer has done so much to illustrate the morbid anatomy of the brain, spinal cord, and nerves.

This extension of the field of anatomy into the minutest tissues which the microscope can show has been favoured greatly by the facility and economy with which optical instruments of great power and accuracy of definition are now manufactured. So that the student can easily verify for himself with his own instrument the existence and character of the structures his teacher describes. He should take nothing for granted ; for what is once seen is never forgotten.

A knowledge, and a pretty accurate knowledge, of physics is absolutely necessary to the proper understanding of the functions of living beings.

The student who enters on the study of physiology without a competent knowledge of these natural laws is like a traveller without guide or compass. His journey is tedious, uncertain, perhaps abortive.

Let me assume that a knowledge of the structure and functions of the human organism has been acquired. It is the starting-point of our art. Morphology, or the knowledge of structure, assures us that the formation of tissues and organs is based on laws of uniform evolution from or out of the germ which, within moderate limits of aberration, is alike in all. So that while the tissues of every individual are a type of those of every other individual, the elemental composition of each separate tissue being the same, yet in the building up of structure from these tissues there may, and frequently does, occur a departure from the standard type,

and an aberration of that uniformity of arrangement which is taken as the starting-point of our anatomical knowledge.

The student learns his anatomy from the dissection of one or more human subjects. He is taught that the distribution and relative position of blood, veins, nerves, muscles, and tissues which he finds in his dissections is typical of what exists in every other subject; and although there is an occasional departure from this fixity of distribution, yet we know well that the cases in which an irregular course of artery or nerve is found are infinitely small, and the exceptions so minute as to be on the whole disregarded.

It is this uniformity of structure, this strict similarity of arrangement, that gives confidence to the surgeon in all his operations, and enables him, far beyond the influence of sight, to guide his instrument with unerring certainty, and plunge his knife with safety to the patient among the most intricate structures.

The functions of the several organs are equally identical, and the circulation, the respiration, the digestion, the excretion and secretion of one is typical of the same processes in all.

Our position up to this point is that of a science strictly inductive. Structure and function have been made out by minute inquiry and patient observation.

We have obtained a standard for comparison, a standard which represents the average or normal condition in structure and function of the whole class.

The point established is that anatomy and physiology have demonstrated a fixed arrangement of parts and determinate processes of function common to every individual of the class human.

In furtherance of the task I have before me, of placing the

science and art of medicine in its proper position in relation to other branches of natural science, it is necessary to observe and account for the external agencies or powers operating on the organism, giving rise to the phenomena of life.

The lungs cannot act without air, nor the stomach supply nourishment without food. But the air must possess certain definite properties, and the food must be such as will nourish and support the vital energies. The water to moisten it must be pure, and the temperature surrounding the organism must range within certain limits.

Physiology teaches all this, and proves that there are three fundamental external agents essential to the development and maintenance of life—a definite temperature, atmospheric air, and moist elements of food.

If either of these separately, or the whole conjointly, are deficient, or vary beyond certain limits, disturbed function follows. This disturbance in the equilibrium of function is the first manifestation of disease or disordered action.

To sustain the body, therefore, in health, there must be a continuous and reciprocal action between the functions of the body and those external agents on the co-operation with which the manifestation of the processes of life depends.

HEALTH.

Take the human organism in a state of complete development, assume that all the organs and several parts are acting harmoniously and in concord with the external agents by which life is sustained, and we have the condition we call *health*.

It is a condition of equilibrium in which the functions of respiration and circulation, of digestion and nutrition, of

secretion and excretion, of voluntary motion, as well as the higher orders of functions performed by a complex cerebro-spinal mass—the material world acting through the senses of sight, smell, hearing, taste, and touch, developing sensation, perception, and self-consciousness—all working in such harmony and such perfect unison towards a definite end and purpose, that the individual is unconscious of any separate function, the operation of the whole going on silently and unnoticed, evolving a sense of calm enjoyment, undisturbed and unruffled except by the pleasurable excitement of an instinct or an appetite ungratified.

Such is health ; but what is disease ?

Disease is not an entity, which the nomenclature of disease would lead one to suppose, and which it is quite evident *was*, and with some may be *now*, the prevailing idea. Rheumatism, apoplexy, pneumonia, were looked on as definite and distinct somethings, to be contended with and turned out. That, however, is not the present error ; these and innumerable other names are only terms employed to indicate some disturbed process or function, or some structural change going on in special parts.

The study of the causes of these structural changes and disordered functions is the province of pathology. It traces the causes, conditions, symptoms, and effects of whatever disturbs the equilibrium of health.

It finds that the cause of disease may be traced either to conditions external to or acting from without the organism, or to causes springing up within the organism itself.

That is, the forces required to drive the machine may be excessive, or disproportioned to the work to be done ; or the machine itself may be out of gear from some cause within itself.

The first are usually called the exciting causes of disease, the second the proximate. The proximate comprise the susceptibility of individuals, or the proclivity of each person to suffer more in one organ or function than another, a susceptibility either acquired by habits of life, inherited by parentage, or incidental to age or sex, for both age and sex have their special susceptibilities.

The disorders of childhood are very different from those of age; there may be some common to both, but of each period it must be acknowledged there are distinct disorders.

So of sex. Some diseases are peculiar to one, some to the other. Many diseases are acquired by unhealthy occupations—unhealthy as to the occupation itself, or unhealthy only as to the locality or place in which it is carried on. Habits of life, whether as regards diet or regimen, exercise a marked influence over the development of disordered action.

Parentage, hereditary taint, is no less a widespread one.

It is the object of general pathology, by inquiring into all the conditions (causes, symptoms, and consequences of disease) capable of disturbing the equilibrium of health, to bring, by a well-arranged series of facts, a vast amount of information relating to the health of the individual, as well as of the community at large; for the life and health of the individual is inseparably bound up with the health of the community, of which he is but an integral part.

Pathology, therefore, not only investigates the probable causes of disease in the individual, but extends its researches over a far wider and even more important field, and inquires into the causes which, common to all, interfere with the life and health of the people at large.

Medicine, as an art, from its earliest records has recog-

nised the prevalence at times of particular types of disease, or the springing up of certain types in specified localities.

To trace the origin, the mode of propagation, and the means of restraining the prevalence or the mortality of epidemics, is one of the most important duties of our profession ; and though but little success has yet resulted from the most patient and exhaustive inquiries into the origin and means of arresting the ravages of such epidemics as those of cholera or scarlet fever, yet over one fearful scourge the genius of Jenner has triumphed, and victory, complete and undoubted, has been the result of the contest between vaccination and smallpox.

There can be no higher aim or more beneficent purpose for any science to accomplish than to stamp out the causes which originate, or the conditions which tend to propagate, disease of whatever kind, amongst the community. There can be no nobler cause than efforts to control the ravages of disease among the congregated masses of large towns.

To investigate the cause of the insalubrity of any given locality, to propose means for the sanitary welfare of large and populous places, is not only the duty, but the paramount duty, of our art. To accomplish such beneficent objects requires a mind of special training. One severely trained to exact and patient observation, skilled in all the collateral branches of medicine. A chemist, a physiological one, intimately conversant with the morbid agencies of air defective in purity and with its several sources of contamination, of the influence of soil and drainage on animal health, of the qualities of water and its impurities, and the effect of these on the health of the community. He should know something of the construction of dwellings, the cubic contents of rooms in proportion to the number of those living in them, and the best means for ventilating and maintaining a supply

of respirable air. Of all these subjects he should know much and well. He must know also the influence of particular kinds of labour on health, and the several diseases peculiar to special trades and occupations.

In addition, therefore, to a high-class medical education should be added sound judgment, tact in dealing with the prejudice or ignorance of people, and a power to persuade by reasoning rather than dictating by authority.

It is clear from this summary that every medical practitioner is not qualified for the duties of a sanitary officer.

In investigating the causes and conditions affecting either the health of the individual or of that of the community, while the basis of our observations is founded on inductive or natural science, yet our deductions or conclusions have not the certainty, nor are we capable of producing proofs, or generalising to an extent sufficient, except in a few instances, to form a law, as the facts in natural science so conclusively lead.

Moral probability, or possibility, or, at most, moral certainty, not demonstrable proof, is the result to which our facts and generalisations can at best arrive.

Two individuals may be exposed to the disturbing influence of, we will say, marsh miasm, or the contagion of fever, or the exciting cause of catarrh, but not only will they not suffer alike, but while one may pay the forfeit of his life another may escape unscathed.

Again, in the ravages of any given epidemic—smallpox, scarlet fever, cholera, enteric fever—although the type of the symptoms will be similar in each individual, yet it is impossible to do more than conjecture what the termination may be in any individual case.

This conjecture as to results, in the hands of a careful

observer, one trained to habits of cautious observation, approaches almost to a moral certainty.

It is this which constitutes the difference between a skilled and unskilled practitioner. The one, by experience, is able to identify circumstances and conditions which arise from, or are generated by, organs in a certain state of disturbance. Long observation and the comparison of post-mortem results with symptoms occurring during life, have enabled him to fix with some certainty the probable result. But it is, after all, but probable; in extreme cases there may be a moral certainty of the result predicted; it is, however but a deduction drawn from analogy—the comparison of other and supposed similar cases.

In therapeutics, or the employment of remedies for the treatment of disease or deranged function, there is a similar want of absolute certainty or demonstrative proof of the results desired.

As a rule, purgatives purge, narcotics narcotize, stimulants stimulate, each individual to whom they may be administered. But how different in degree—how different in their remote effects—how impossible to predict with certainty or to measure with scientific exactitude the result. The dose or quantity which will cause a drastic, drenching purge on one will scarcely operate on another. The narcotic which stupifies one will scarcely induce sleep in another. The stimulant which will make one man drunk will barely excite another, and still wider differences may be observed in the remote effects produced by these and similar remedies.

What skilled and trained observation, then, is requisite to guide the practitioner where exactitude and certainty are impossible, and where moral probability is the nearest

approach to any proposed result which our present knowledge of the effects of remedies will permit.

CONCLUSION.

What position, then, does medicine hold in relation to the other arts and sciences ?

It is a science, so far as it is based on cautious and trained observation, guided by a competent knowledge of the laws of the material world.

It is an inductive science, in that it deduces conclusions from an accumulation of accurately collected facts concerning the structure and functions of the human body, from which a few general laws have been inferred.

As a science, its foundations are deep and secure in many branches of natural science.

But it is an art, inasmuch as it requires much skill and judgment in the exercise of it. The successful employment of it is regulated by a certain cautious logic rather than by the infallible inferences of induction.

Medicine, then, is the science of observation applied to the investigation of everything which relates to the health of man, individually or socially.

It is based on a thorough knowledge of the structure or organization of man and of the chief families of the animal and vegetable world—a complete knowledge of the functions and powers of the different organs of man and animals, added to which must be a competent acquaintance with phenomena and laws regulating the principal forms of matter ; and if all this be based on a moderate acquaintance with mathematical or exact science, the mind of the indi-

vidual may be said to be efficiently trained for the exercise of every duty belonging to the profession of medicine.

The need for these accomplishments, the necessity for such high-class education, may not be at first fully recognised; but it must be recollected that the problems daily presented to the physician and surgeon cannot be solved by stated formulæ.

The effects of disease, its duration and treatment, its termination, can only be judged and solved by experience, which is only another term for trained observation. Opinion is governed by the balance of probability, or by the inferences of common-sense.

The correctness of the judgment can only be tested and proved by the result, or made probable by two minds efficiently trained coming to the same conclusion on the same data.

Such, then, is medicine as an art.

It is a science, in relation to the means or sources from whence it is derived, for it is built up of many, if not all, of the other natural sciences. It is an art, however, in its exercise, and its value is proportioned to the scientific training, the tact and judgment, of the individual practising it—an art which, for extent and variety of knowledge possessed by its more distinguished members, is not exceeded, scarcely equalled, by any. Its utility is universal, for it is with advantage and benefit exercised in every region of the world, alike useful to all nations, peoples, or creeds. It is most useful when apparently least needed, for its highest mission is to prevent, not cure, disease—to mitigate the evils of ignorance and disregard of the laws of life. It gives rules for the conduct of life in health, rather than attempts the abortive effort to cure that which experience

teaches to be incurable. Nor does it vainly seek to avert the inevitable law of all organized structures, that of decay and death, but endeavours rather to prevent the premature arrival of either.

It is an art, to be educated in which brings to the possessor, not only all the advantages and graces of a liberal and enlightened education, but trains the mind to the contemplation of man, both in his individual as well as in his social state. It teaches him to investigate and learn the laws regulating the formation of the germ out of which his organization springs. It makes him acquainted with the minutest elements of his own structure as well as that of other organized beings. It brings before him the laws regulating nutrition, governing development, or ministering to decay, the premature tendency to which it is the effort of his training to avert.

It is an art not contented with becoming acquainted with the corporeal or physical condition of man; it is bound to study his moral nature, to know the psychical condition of the individual, the influence of the emotions or passions on the corporeal state, the character and power of the intellect, the sources and causes of its derangement, the nature of these aberrations and their influence over the health of the individual, and it teaches or attempts to find the line which marks the limits of personal responsibility for acts performed beyond the control of reason.

It is an art which deals in no dogmas or authoritative dicta. It regards as true or reliable only that which is susceptible of demonstration and proof.

It seeks no converts; for the essence of its teaching is that its followers must be ever students, for, in the words of Harvey—and how ardently all true workers accept his words—

“ that all we know is still infinitely less than all that remains still unknown.”

In our art there is no fealty sworn to authority, and only that which is ancient is loved which experience or science has proved to be true.

The science on which our art rests cannot be learnt or taught from books. The fabric of nature and of the material world must be investigated and studied, and each step the student makes is a progress steadily from one demonstrated fact to another.

In our art the theories of incomplete observation are perpetually being tested by the numerous and reliable facts which experience accumulates and which scientific experiment verifies or ignores ; and thus, gathering within herself the tributary streams of many branches of natural science, each contributing some truth or fact applicable to the interpretation of the laws of health and disease, Medicine may consistently take her place among the arts and sciences, and claim a position among the most useful and beneficent of the scientific pursuits to which the intellect of man can be devoted.

